Space Weather Technical Forecast

Issued on Monday, 13 June 2022 at 13:09 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-flares. Chance of Active fluence Days 3 and 4 (15-16 June). Chance of G1/Minor Storms mainly Day 3.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity was Moderate in the last 24 hours, with a long duration M3 flare that peaked around 13/0400 UTC, most likely originating from AR3032. There are now seven sunspot regions on the visible disc, the most complex of which is AR3032 in the northeast. This has recently developed a small delta spot. AR3030 and AR3031 both showed signs of decay. AR3033 and two new regions near the east limb are all still difficult to classify due to the viewing angle. A further new region has emerged near AR3031. A large CME was observed in association with the M3 flare. Analysis of this is ongoing, but the bulk of the ejecta is likely to miss behind Earth's orbit, with a chance of a glancing blow at Earth, perhaps on 15 June.

Solar Wind / Geomagnetic Activity: The solar wind speed, as observed by DSCOVR at L1, showed an ongoing coronal hole high speed stream. Wind speeds rose slightly from just above 450 km/s to vary between 500-550 km/s. Density has been mostly average. Total Interplanetary magnetic field strength, Bt, has been moderate but on a slight declining trend. The north-south component, Bz, varied moderately between +12/-11 nT. The phi angle was positive (away from the Sun). Geomagnetic activity was Quiet to Unsettled, with a G1/Minor Storm interval between 13/0300-0600 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) was at Background levels. Electron flux (greater than 2MeV) was also at background levels. Corresponding 24-hour integrated electron fluence has been well below the Active (1e8 integrated pfu) threshold on a largely steady trend, with 1.55e6 integrated pfu observed at 13/0000UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to be mainly Low through this period, with C-class flares expected and a chance of M-class flares.

Solar Wind / Geomagnetic Activity: A large CME was observed in association with the earlier long duration M3 flare. Analysis of this is ongoing, but the bulk of the ejecta is likely to miss behind Earth's orbit, with a chance of a glancing blow at Earth, likely early on 15 June +/- 9 hours. Solar wind speeds are currently elevated under the influence of a coronal hole high speed stream. They are likely to decline somewhat to slightly elevated levels through the next two days. They are expected to rise again on Days 3 and 4 (15th and 16th) to elevated levels, under the influence of the high speed stream from CH91 and CH90. Geomagnetic activity is expected to be mainly Quiet to Unsettled with a chance of Active intervals. There is just a slight chance of G1/Minor Storms due to coronal hole influences, then a chance of G1 if we do see a glancing blow from the CME mainly on Day 3.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10 MeV) is expected to be at background levels during this period. High energy electron flux (greater than 2

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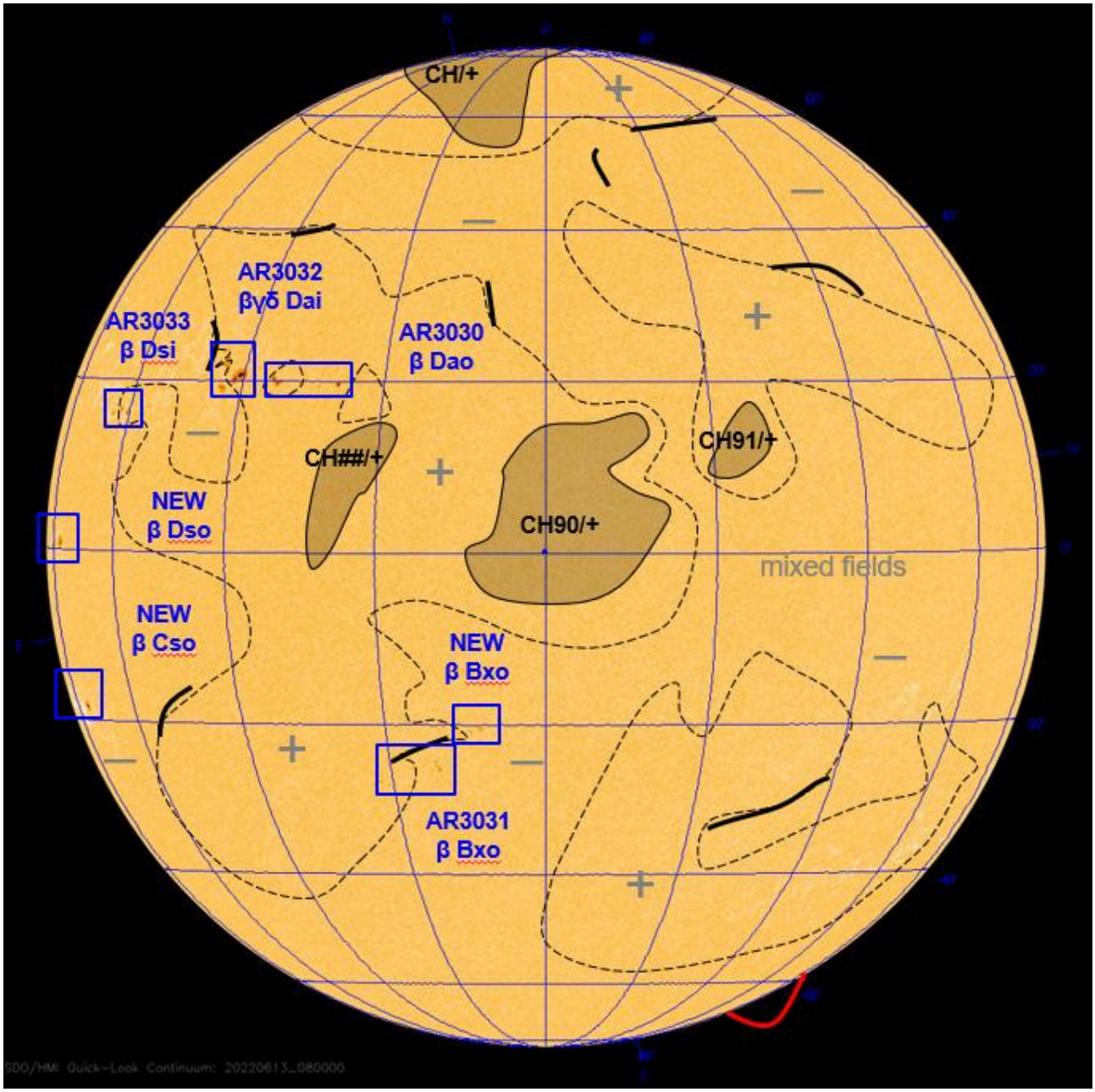
MeV) is expected to start at background levels but may increase to moderate or perhaps high levels during the period, due to high speed stream influences. Electron fluence is expected to follow a rising trend, with a chance of reaching Active (1e8 integrated pfu) levels later in the period.

Figure 1. Solar Analysis Valid 13/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A large CME was observed in association with a long duration M3 flare from near AR3032 peaking around 13/0400 UTC. Analysis of this is ongoing, but the bulk of the ejecta is likely to miss behind Earth's orbit, with a chance of a glancing blow at Earth, likely early on 15 June +/- 9 hours.

Solar wind speeds are currently elevated under the influence of a coronal hole high speed stream (HSS). The source of this fast wind is uncertain but may be due to CH89/+. This feature was facing the Earth a few days ago but was small and is no longer visible. The HSS from CH91/+ is likely to reach Earth on Day 3 (15 June). It is however small and only likely to give slightly elevated wind speeds. The most significant coronal hole is by far CH90, now just west of the central meridian. This is a recurrent feature that generated solar wind speeds of around 500-600 km/s on the last rotation. Similar values are therefore expected this time round, most likely on Day 4 (16th) given the location of CH90 on the visible disc.

Wind speeds at STEREO-A suggest winds at Earth are likely to decline somewhat to slightly elevated levels through the next two days. They are expected to rise again on Days 3 and 4 (15th and 16th) to elevated levels, under the influence of the fast wind from CH91 and CH90. Geomagnetic activity is expected to be mainly Quiet to Unsettled with a chance of Active intervals. There is just a slight chance of G1/Minor Storms due to coronal hole influences, then a chance of G1 if we do see a glancing blow from the CME mainly on Day 3.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	5	5	30	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
13/0645 UTC	Partial	AR3032	NE quadrant	1150 km/s	15/0600 UTC +/- 9 hours	Likely miss, but possible glancing blow

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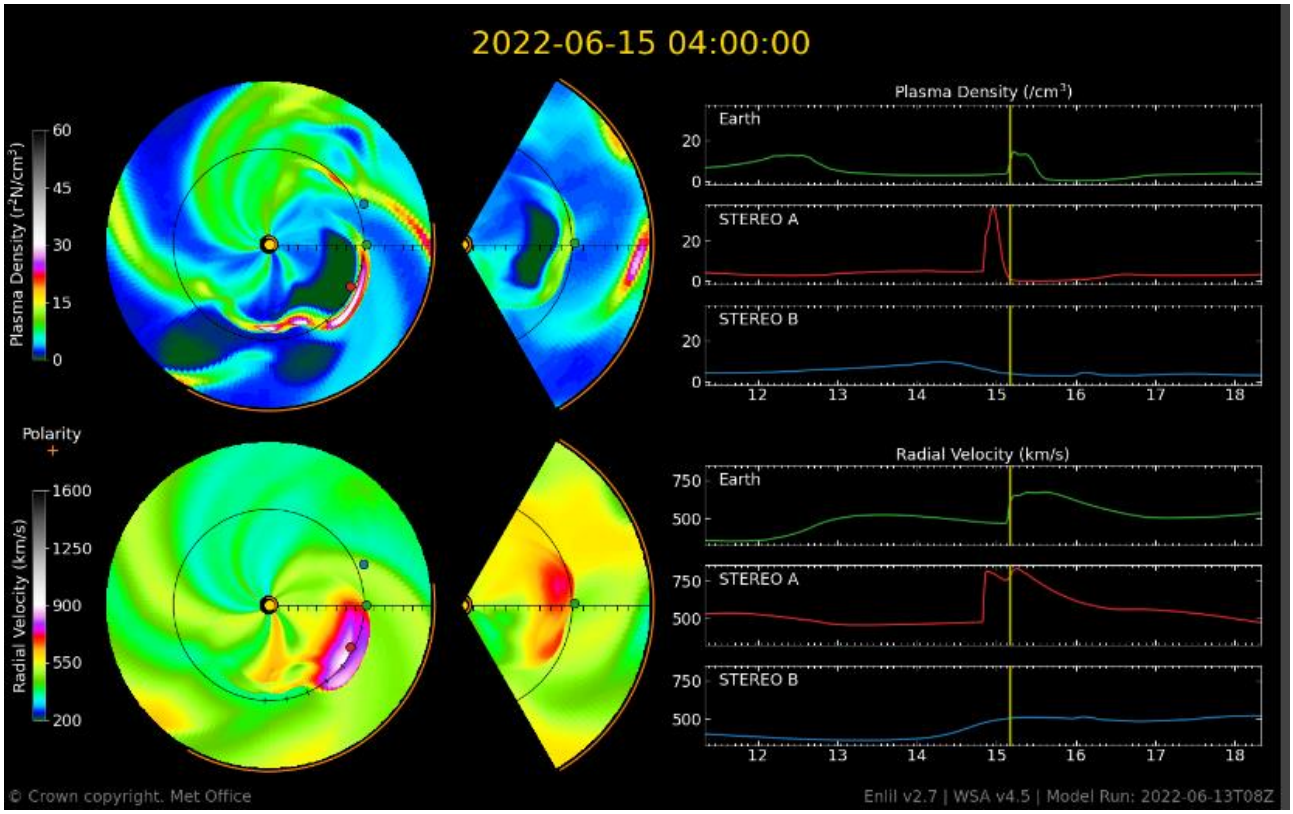
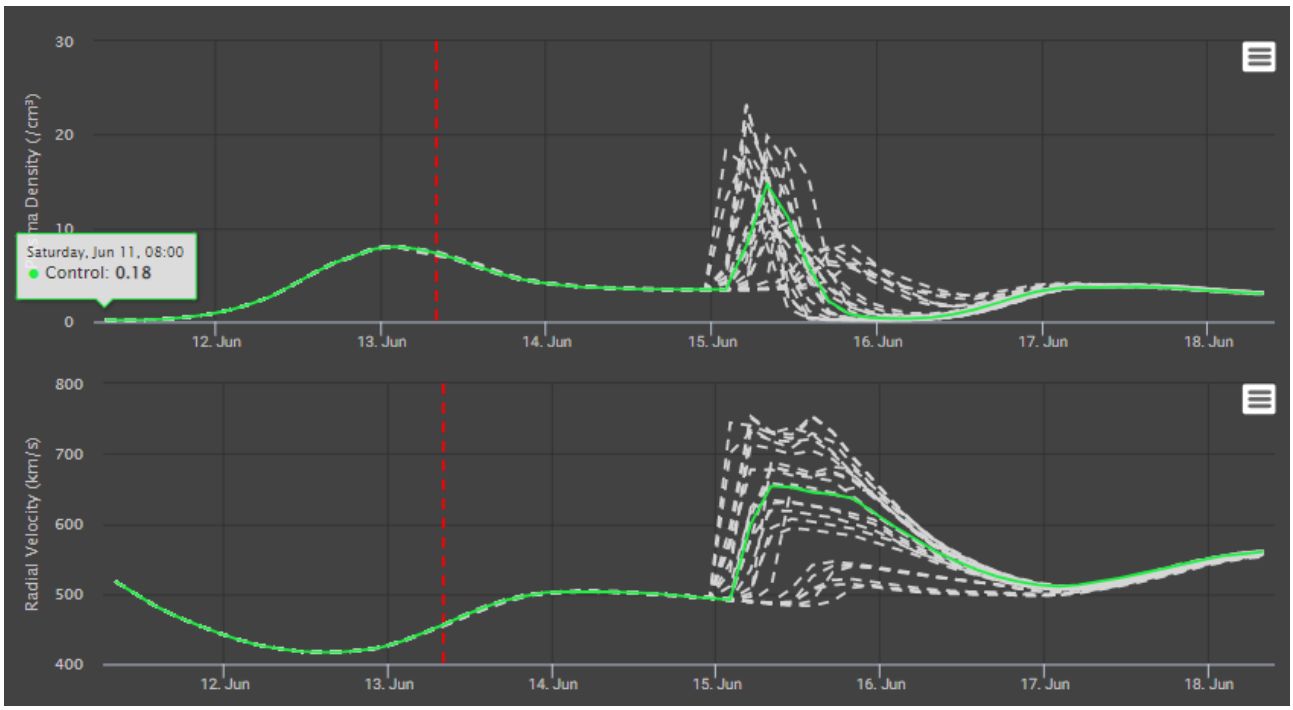
Figure 2: Enlil and ensemble suggesting a possible glancing blow from a CME early on 15 June.





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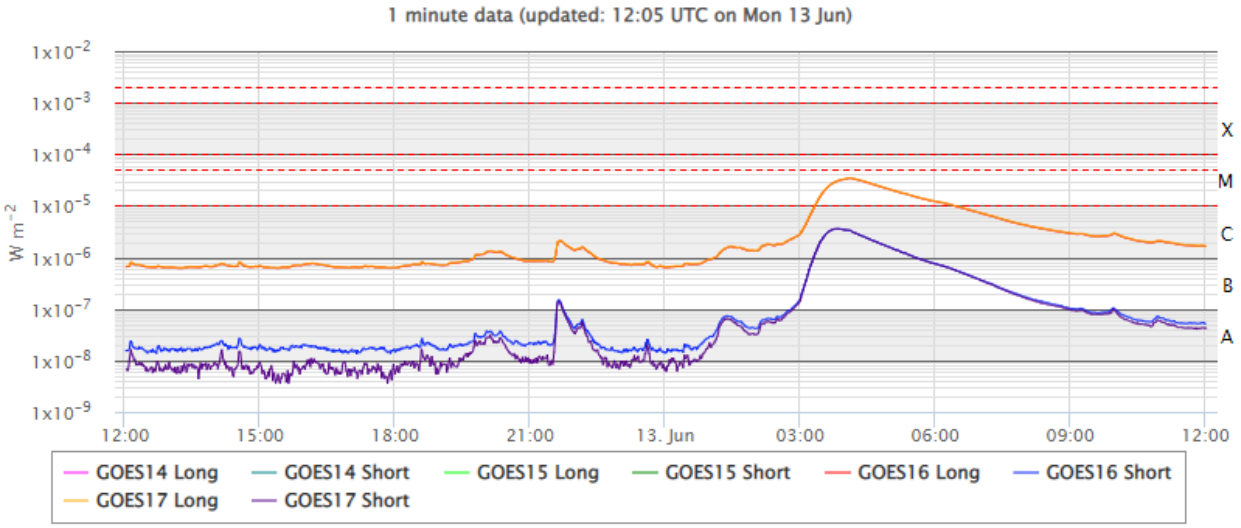
Radio Blackouts - X-Ray Flares:
Solar activity was Moderate in the last 24 hours, with a long duration M3 flare that peaked at around 13/0400 UTC, most likely originating from AR3032. Further C-flares are expected with a chance of further M-flares, most likely from AR3032. This risk may increase slightly later in the period as potential returning regions transit around the eastern limb.

There are now seven sunspot regions on the visible disc. AR3032 (Dai/Beta-gamma-delta) is the most complex region on the disc, and has now developed a small delta spot. AR3030 (Dao/Beta) continued to weaken, with intermediate spots fading. AR3033 (Dsi/Beta) is becoming clearer as it rotates further onto the disc, with more spots becoming apparent. The two new regions near the east limb (Dso/Beta and Cso/Beta) are both revealing trailing spots as they rotate further onto the disc. AR3031 (Bxo/Beta) is slowly fading, but there is a new region emerging just to the northwest of this region (also Bxo/Beta).

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	30	30	35	40
Very Active	R3 to R5 X Class	No	5	5	5	10

Figure 3: Long period M3 flare from AR3032 peaking around 13/0400 UTC.



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Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) is at background levels and is currently expected to remain at this level through the period, albeit with a slight increase as the current spots transit westwards.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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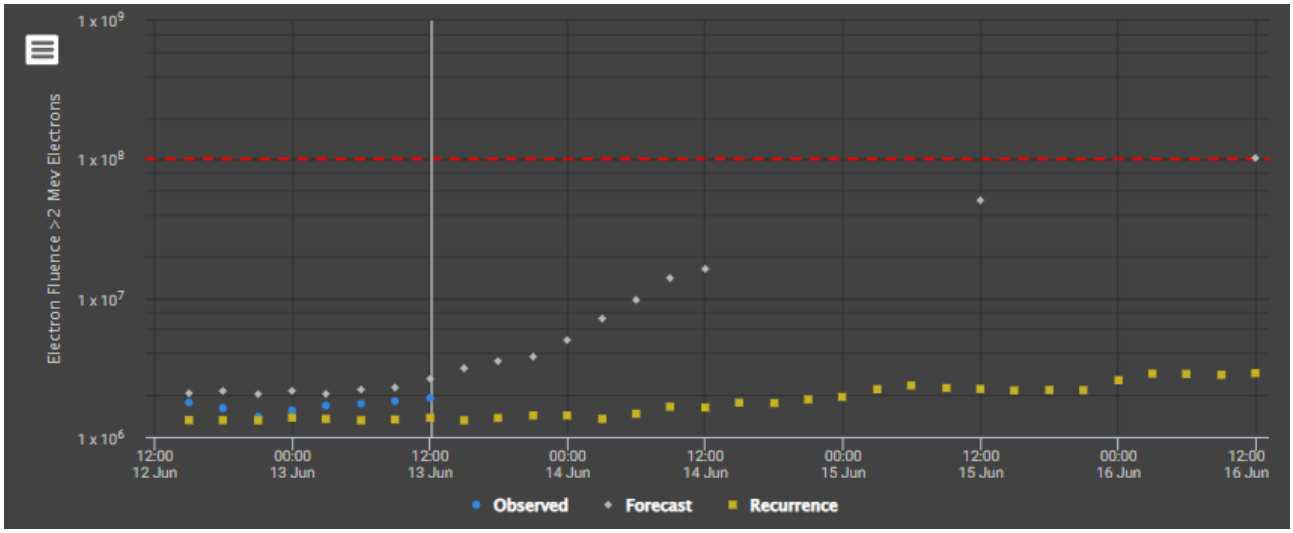
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) as observed by GOES-16 is currently at background levels. High speed stream influences are now giving elevated wind speeds with some geomagnetic activity, which could start to cause some electron charging. Therefore an increasing trend is now considered more likely than previously, reaching Moderate levels during the period, and perhaps with diurnal High peaks. A potential CME arrival during Day 3 (15 June) however would suppress flux levels were this to occur.

Electron fluence is currently well below the Active (1e8 integrated pfu) threshold. A rising trend is now considered likely, although with the possibility of the CME suppressing this rise during Day 3. Overall, it is considered that there is a chance of reaching Active levels, especially if the CME does not reach Earth. MOSWOC REFM is now suggesting a rise to just below Active levels by Day 3, which seems like a reasonable trend.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	10	30	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM suggesting a rise near Active levels by Day 3, which is accepted as a trend.



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